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B&F ENGINEERING, INC.
928 Airport Road • Hot Springs National Park, Arkansas 71913 • (501) 767-2366

June 3, 1991

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U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200 6H-CS
Dallas, Texas 75202-2733

ATTN: Mr. Gary Miller

RE: Thomason Lumber & Timber Co.
B&F Job No. 7-2397-0101

Dear Mr. Miller:

Please find the enclosed Site Investigation report for the Thomason Lumber and Timber Company Wood Treating facility in Broken Bow, Oklahoma.

This document has been prepared and submitted pursuant to Consent Agreement and Final Order (Docket Number RCRA VI-605-H). If you have any questions regarding these documents, please do not hesitate to contact us.

Sincerely,

B & F ENGINEERING, INC.

Peter W. Bayley,
Project Hydrogeologist

PWB/ss

Enclosure

cc: Jack Badgett - OSDH

B&F ENGINEERING, INC.
928 Airport Road • Hot Springs National Park, Arkansas 71913 • (501) 767-2366

June 4, 1991

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U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200 6H-CS
Dallas, Texas 75202-2733

ATTN: Mr. Gary Miller

RE: Thomason Lumber & Timber Co.
B&F Job No. 7-2397-0101

Dear Mr. Miller:

Please find the enclosed revision sheets for Volume I of the Site Investigation (SI) report dated May 31, 1991. Please replace those pages in the SI report with the enclosed pages. The pages which have been replaced should be returned to us in the enclosed self-addressed stamped envelope. We apologize for this inconvenience and appreciate your cooperation.

Thank you.

Sincerely,

B & F ENGINEERING, INC.

Peter W. Bayley
Project Hydrogeologist

PWB/ss

Enclosure

cc: Jack Badgett - OSDH

SITE INVESTIGATION REPORT

FOR

THOMASON LUMBER AND TIMBER COMPANY
WOOD TREATMENT PLANT
BROKEN BOW, OKLAHOMA

PREPARED FOR:

THOMASON LUMBER AND TIMBER COMPANY
P.O. DRAWER 278
BROKEN BOW, OKLAHOMA 74738

PREPARED BY:

B & F ENGINEERING, INC.
928 AIRPORT ROAD
HOT SPRINGS, ARKANSAS 71913
501-767-2366

MAY 31, 1991

B&F NO. 7-2397-0101

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Volume II: Potentiometric Surface Contour Maps

1.0 INTRODUCTION

1.1 Executive Summary

As part of a Consent Agreement and Final Order (Order) (Docket Number RCRA VI-605-H) with the United States Environmental Protection Agency to close inactive hazardous waste management facilities, Thomason Lumber and Timber Company has agreed to conduct a site investigation to define the nature and extent of possible contamination beneath the Waste Pile site, Lagoons 2 and 3, and the Process Area. The data collected during the investigation of the Waste Pile indicate that this hazardous waste management unit can be clean closed. However, the data collected during the soil and ground water investigation of Lagoons 2 and 3 indicate the presence of wood preservative constituents in both the soil and ground water at the site. Thomason, therefore, proposes to close Lagoons 2 and 3 as on-site landfills. The closure plan for these activities is submitted on May 31, 1991 as a companion document to the Site Characterization Report dated May 31, 1991. Activities at the subject site to reduce run-on, run-off and other environmental concerns in the Process Area include the construction of roofed structures and remediation of the Resource Recovery Area.

1.2 Site Location

Thomason Lumber and Timber Company (Thomason) owns and operates a wood treating plant southeast of the community of Broken Bow, in McCurtain County, Oklahoma. The plant is located south of U.S. Highway 70 and East of Silvey Road, and occupies portions of the west half of the northeast quarter of Section 19, Township 6 South and Range 25 East. Figure 1.1 presents the location of the plant in relation to the southeastern Oklahoma region, and Figure 1.2 presents the location of the plant in relation to the Broken Bow vicinity.

1.3 Site Regulatory History

On December 16, 1980, representatives of the U.S. Environmental Protection Agency (EPA) inspected the Thomason site under authority granted by the Resource Conservation and Recovery Act of 1976 (RCRA). During that inspection, potential hazardous waste sites were evaluated. K001 wastes, as described by 40 CFR Part 261, were found at the site. These wastes are defined to be bottom sediment sludges from the treatment of waste waters from wood preserving processes that use creosote and/or pentachlorophenol.

The previous owners of Thomason notified EPA of hazardous waste activity at the facility on March 9, 1981, pursuant to Section 3010(a) of RCRA. This notification identified Thomason as a generator and treater, storer or disposer of the following listed hazardous wastes:

- o Pentachlorophenol (F027)
- o Bottom sludge from the treatment of waste water from wood preserving processes that use creosote and/or pentachlorophenol (K001).

In March, 1985 the present owners of Thomason entered into a consent agreement with the Oklahoma Water Resources Board (OWRB) to close the inactive lagoons at the Broken Bow facility. That agreement directed Thomason to remove the material from the two decommissioned surface impoundments (Lagoons 2 and 3) and send it to a permitted facility for disposal. The agreement also directed Thomason to fill and close the lagoons. The OWRB notified the Oklahoma State Department of Health (OSDH) in March, 1985 of the consent agreement with Thomason, and of the subsequent closure plan. The OSDH did not intervene at that time as the agency of jurisdiction, and Thomason implemented the plan. United States Pollution Control, Inc. (USPCI) was contacted about receiving the wastes at the Lone Mountain disposal facility, and had indicated that the waste would be acceptable. Based on that information, Thomason removed and stockpiled the material from the pond bottom, subsequent to transport for final disposal. Thomason also backfilled the ponds with clay material, revegetated, and fenced the areas of concern.

Although USPCI initially indicated to Thomason that the stockpiled waste would be accepted for disposal at their Lone Mountain facility, problems at the facility resulted in their delay and, finally, their refusal to file a disposal plan for the facility. As a result, Thomason was unable to dispose of the stockpiled waste at that time through USPCI. Thomason then contracted with Chem Waste Environmental Transporters (Louisiana) to transport and dispose of the waste.

On September 4, 1985, the OSDH conducted an inspection of the Thomason facility. The inspector indicated to Thomason that the lagoons had contained listed hazardous waste, and were therefore, considered to be Treatment/Storage/Disposal (T/S/D) facilities regulated under the Resource Conservation and Recovery Act (RCRA). As a result, the closure of those lagoons should have been regulated by the OSDH, and Thomason had unknowingly violated state regulations by closing the lagoons without the OSDH approval.

In an effort to clarify regulatory roles and to assure that the plant was in regulatory compliance, Thomason corresponded with the OSDH requesting a meeting to clarify regulatory responsibilities and requirements. Based on that request, a joint meeting was held among the OSDH, OWRB and Thomason at McAlester, Oklahoma in October, 1985. At that meeting, the OSDH indicated that they were the lead agency regulating the lagoon closures, and that they would issue a warning letter to Thomason stating what was necessary to bring the plant into regulatory compliance. Thomason received that correspondence on February 13, 1986. The letter from the OSDH provided a 30 day period in which to address the listed citations.

On January 7, 1986, the United State Environmental Protection Agency (EPA) conducted an inspection of the Thomason site. At that time, the EPA indicated that they had assumed jurisdiction for the Thomason facility, and were now the lead regulatory agency. This inspection was followed by a compliance order from the EPA on February 24, 1986, addressing essentially the same concerns as the OSDH letter.

Because it was not clear who was acting as lead agency, and what schedules were effective for compliance, Thomason requested a joint meeting with the EPA and OSDH to clarify these points. That meeting was held on March 10, 1986, and resulted in an agreement that Thomason should request a settlement conference to address these concerns. Thomason requested that conference in correspondence dated March 24, 1986.

The settlement conference was held on August 1, 1986. At that conference it was determined that the EPA compliance order, as revised by negotiation, would be the effective order. The OSDH agreed to accept that order. The EPA would act as lead agency, but the OSDH would have the right of review and approval, via comments, to EPA.

Subsequent to that meeting, various aspects of the compliance order were negotiated. Final agreement was reached in an agreement signed on December 24, 1986 and received by Thomason on January 5, 1987.

Documents submitted by Thomason for compliance with the consent order include:

1. Part A Application (February 5, 1987);
2. Site Geohydrologic Investigation Plan (February 4, 1987);
3. Sampling and Analysis Plan (February 4, 1987);

4. Process Area Sampling and Analysis Plan (February 4, 1987);

5. Closure Plan (February 4, 1987);

6. Preliminary Site Investigation Report (February 12, 1988) (Revised September 28, 1988);

7. Ground-Water Sampling and Analysis Plan (February 23, 1990);

8. Piezometer Installation and Preliminary Groundwater Quality Report (April 30, 1990).

The Closure Plan submitted by Thomason on February 4, 1987 presented a plan to investigate and close the Waste Pile, and Lagoons 2 and 3, as required by the order. As discussed above, certain closure activities conducted by Thomason were the result of inaccurate information and confusion as to which regulatory agency had jurisdiction. The completion of the site soil and ground-water monitoring investigation has provided the necessary data to prepare the Closure Plan dated May 31, 1991. The Closure Plan is based upon the results of the soil and ground water analytical data contained in this report.

During July - August, 1990, the Resource Recovery Area was remediated under the jurisdiction of the Oklahoma State Department of Health (OSDH). All visibly contaminated soils were removed from the site. The area was sampled and additional soils were removed until a clean closure was attained. The site was backfilled to original grade with clean soils and revegetated. The removed contaminated soils were transported to a permitted hazardous waste management facility for permanent disposal as per agreement with the EPA and OSDH. A roofed metal structure to enclose the treating plant was constructed, and the design for a new drip pad facility was designed during the spring of 1991.

1.4 Site Investigation History and Purpose of Report

As part of the Waste Pile, and Lagoons 2 and 3 closure, Thomason conducted a site investigation to determine the concentrations of wood preservatives (PCP and selected creosote constituents) in the soil and ground water beneath those units. The investigation also included the resource recovery, process, and kick-back drippage areas. These data were submitted in the Preliminary Site Investigation report dated February 12, 1988.

Based upon the data collected in the Preliminary Site Investigation, Thomason installed piezometers to determine ground-water flow patterns at the site. The piezometers which had been constructed to monitoring well standards, were then administratively designated as monitoring wells in the Piezometer Installation report dated April 30, 1990.

From April, 1990 to February, 1991 ground-water samples were collected at two month intervals from the site and analyzed as specified in the sampling and analysis plan (as modified in sections 5.2 and 6.0 of the Piezometer Installation report). This report presents the analytical results of the ground-water sampling program, and includes analytical data from the soil investigations.

The data presented in the following report provide a basis for determining the method of closure for the waste pile, and lagoons 2 and 3. A more detailed analysis of the method of closure and supporting documentation is presented in the Closure Plan dated May 31, 1991. Documents from previous reports have been included in this report for reference and to provide contingency. However, some of the documents from previous reports have been revised; some for clarity, and some to correct errors and omissions found in the earlier documents. The documents presented herein supersede similar documents presented in their previous respective reports.

2.Ø SITE INVESTIGATION

2.1 Geology

The Thomason Lumber and Timber Company wood treating facility is situated on a narrow ridge which trends roughly west to east. The surface elevation at the site ranges from approximately 494 ft. MSL at MW-2, near the center of the facility, to approximately 455 ft. MSL near MW-6 in the northeastern corner of the site. A clayey gravel ranging from zero (Ø) to 14 feet in thickness covers the central portion of the ridge.

Antlers Sandstone

The Antlers Sandstone underlying the facility ranges in thickness from approximately 45 feet at MW-6, to approximately 1ØØ feet at MW-2. The interbedded sandstones and clays which make up the Antlers Sandstone are of varying thickness and occasionally include carbonaceous and pyritic intervals. Gradational as well as abrupt contacts between the interbedded units occur within this portion of the Antlers Sandstone.

The sandstone units are typically very-fine to fine grained, friable, silty, sometimes clayey, and range in coloration from grey to yellow-orange. Typically the sandstone units are separated by thin clays. The clays tend to be firm, occasionally stiff, typically silty, occasionally sandy, and range in coloration from grey and dark grey to yellow and red-orange.

Based upon outcrop patterns and subsurface information obtained at the site, the Antlers Sandstone is dipping very gently to the south.

De Queen Limestone

The De Queen Limestone beneath the site is characterized by variegated clays with lignitic and pyritic stringers interbedded with very thin micritic and/or fossiliferous limestones. The De Queen Limestone is conformably overlain by the Antlers Sandstone.

2.1.1 Reconnaissance and Outcrop Logging

A surficial geologic reconnaissance of the Thomason property and surrounding area was undertaken by a geologist from B & F Engineering. The lithologies at 12 outcrops within a one mile radius of the facility were observed and logged. These logs are presented in Appendix A of the Preliminary Site Investigation report. Figure 2.1 in this report locates each of the outcrops presented in Appendix A of the Preliminary Site Investigation report (1988).

2.1.2 Subsurface

2.1.2.1 Initial Boreholes

Four boreholes were advanced by wash rotary techniques to characterize the geologic and hydrogeologic conditions of the Antlers Formation. Drawing 1 of this report depicts the location of these boreholes. Each borehole was advanced until limestone and clays characteristic of the DeQueen Limestone were encountered. These boreholes ranged in depth from 73 feet (B-4) to 128 feet (B-2). The logs for these boreholes are presented in Appendix D of the preliminary report.

Core samples from the uppermost clay unit of the Antlers Sandstone encountered in each borehole were tested for physical characteristics. The resulting laboratory permeabilities ranged from 3.6E-7 to 5.6E-9 cm/sec. The Plasticity Index in each case was well above the desired limit of 10. The percent passing the number 200 sieve indicated a desirable particle size distribution. The results of these physical analyses are presented in Appendix E of the Preliminary Site Investigation report (1988).

2.1.2.2 Piezometers

A total of fourteen (14) piezometers were installed as part of the site investigation. The location of each piezometer at the site is presented on Drawing 1 of the Piezometer Installation report (1990). The additional geologic information obtained during the piezometer installation phase of the site investigation was employed in revising the subsurface characterization presented in the Preliminary Site Investigation report (1988). The geophysical logs and cross-sections from the Piezometer Installation report are presented in this report as Appendices A and B respectively. The geologic cross-sections provided in this report reflect a differentiation between "sandstone" and "clay" on the basis of gross lithology. A reflection of the changes in the percent of other materials has not been included for the sake of clarity. Lithologic logs included with the well installation records are presented as Appendix C of this report.

2.2 Soil Sampling and Analysis

The EPA consent agreement required Thomason to determine the type and amount, if any, of hazardous waste and hazardous waste constituents present in the soil beneath decommissioned Lagoons 2 and 3, the Sawdust Pile, Waste Pile, and Process Area. A total of 24 borings were advanced using either a hand auger or a truck mounted drill to depths ranging from 2 to 30 feet. Figure 2.2 and Drawing 1 present the locations of these borings. Logs of the drilled borings are presented in the Preliminary Site Investigation report (1988).

Samples for chemical analysis were extracted from these borings at one or two foot intervals. These samples were analyzed for the following constituents:

- Pentachlorophenol (PCP)
- Naphthalene
- Acenaphthylene
- Fluoranthene

The tabulated results of these analyses are presented in Appendix D of this report.

Included in the site investigation was the excavation of six (6) test pits at the Thomason facility. The location of each test pit is presented as Drawing 2 of this report. Logs of the test pits are presented as Appendix C of the Preliminary Site Investigation report (1988). After each test pit was logged the pit was backfilled with excavated materials. All equipment used in test pit excavation was decontaminated between each excavation, and upon completion of all excavations.

The B&F hydrogeologist at the site was specifically concerned with the identification of any visual evidence of contamination within the test pits. Neither free liquids nor contaminant stains were noticeable when the pits were inspected. The presence of distinctive odors associated with creosote or PCP contamination is more difficult to identify due to the ongoing wood treating operation at the site. Chemical odors, however, were not detected specifically from within the test pits. Soils excavated appeared to be free of contamination.

2.2.1 Process Area

2.2.1.1 Resource Recovery Area

The concentration of wood preservatives in the Resource Recovery Area was characterized by borings HA-5, PA-3, PA-4, PA-5, and PA-6. The samples from HA-5 were collected by hand auger to a depth of two (2) feet. The location of boring HA-5 is presented in Figure 2.2. The PA boring samples were collected using a truck mounted drill. The borings were advanced and samples were collected by splitspoon or thin wall sampler until auger refusal. The location of the PA borings are presented on Drawing 1.

The HA-5 samples were analyzed for both totals and EP-Toxicity. Both PCP and fluoranthene were detected in each HA-5 sample. EP-Toxicity concentrations in the HA-5 samples were lower than the total concentrations. Naphthalene and acenaphthylene were both below detection limits.

The PA borings were advanced at each corner of the Resource Recovery Area. The analytical results of the PA borings are presented in Appendix D. The analytical results from PA-5 and PA-6 were, for the most part, below detection for each parameter tested. Boring PA-5 was found to have relatively low levels of PCP and creosote constituents in the 8 - 1Ø ft. sample interval. The concentrations of analyzed parameters within the Ø - 8 ft. interval of PA-5 were below detection. Analyzed samples from boring PA-6 indicated the presence of relatively low concentrations of PCP (Ø.2Ø + Ø.18 ppm) and fluoranthene (Ø.6Ø ppm) in the Ø - 1 ft. interval. The 1 - 2 ft. interval in PA-6 was found to be below detection for all analytical parameters. Samples from PA-3 showed the presence of PCP and fluoranthene in the interval between Ø and two (2) feet. The concentration for PCP and fluoranthene in samples from PA-3 ranged from 38 to Ø.Ø55 ppm for PCP and from 1.7 to Ø.15 ppm for fluoranthene in the Ø - 1 ft. and the 1 - 2 ft. intervals, respectively.

Boring PA-4 was one of three (3) borings completed to a depth of ten (10) feet. Samples from PA-4 indicated the presence of PCP at lower levels in all samples. Acenaphthylene had been detected at 0.34, 0.14 and 0.93 ppm in the 0 - 1 ft., 2 - 3 ft., and 5 - 6 ft. intervals of PA-4, respectively. Naphthalene was detected at 1.2 and 0.11 ppm in the 0 - 1 ft. and 6 - 7 ft. interval respectively.

2.2.1.2 Plant Area

The presence of PCP and creosote constituents in the Plant Area was determined by collecting soil samples using a hand auger and a truck mounted drill. Hand auger sample locations (HA-1, HA-3, and HA-4) are depicted on Figure 2.2. No samples were obtained at HA-2. Drill locations (PA-1, PA-2, and PA-7) are shown on Drawing 1. Analytical results have been tabulated and are presented in Appendix D.

The soil samples collected from HA-1 were analyzed for total concentration of PCP and selected creosote parameters. The 0 - 1 ft. interval indicated that 75 ppm of PCP and 18 ppm of fluoranthene were present. Concentrations of those constituents decreased to 6.2 ppm (PCP) and 3.4 ppm (fluoranthene) in the 2 - 3 foot sample interval. Naphthalene and acenaphthylene were below detection (< 0.5 ppm) in all samples.

The soil samples collected from HA-3 and HA-4 were analyzed for EP-Toxicity, with respect to PCP and selected creosote parameters. The maximum EP-Toxicity concentration of PCP detected was in the 0 - 1 foot interval of HA-3 (3 ppm).

Creosote constituents above detection limits for EP-Toxicity were not found in HA-3. HA-4 EP-Toxicity analysis indicated the presence of PCP (1.3 ppm) and fluoranthene (Ø.Ø22 ppm). Other creosote parameters were below detection.

The soil samples collected from the Plant Area borings indicated the presence of wood treating constituents in the Ø - 1 ft. interval of both PA-1 and PA-7. The 1 - 2 ft. interval of each of these borings was below detection for each parameter tested. The PA-2 boring indicated only low concentrations of PCP (ranging from Ø.Ø51 ppm to 4.5 ppm) in the following intervals; 2 - 3 ft., 3 - 4 ft., 4 - 5 ft., 8 - 9 ft. and 9 - 1Ø ft.). In all other intervals PCP was below detection (<Ø.Ø5 ppm). Detected concentrations of creosote parameters ranged from Ø.24 ppm to Ø.35 ppm in the following intervals of PA-2; 2 - 3 ft., 8 - 9 ft. and 9 - 1Ø ft. All other intervals were below detection (<Ø.1 ppm) for creosote parameters.

2.2.1.3 Kick-Back Drippage Area

The concentrations of PCP and creosotes in the kick-back drippage area were characterized by borings PA-8, PA-9, PA-1Ø, PA-11, PA-12, and PA-13. The locations of these borings are shown on Drawing 1. The analytical results of the kick-back drippage borings are presented in Appendix D.

The highest concentrations of both PCP and creosote constituents were detected in the Ø - 1 foot interval of each boring. The maximum concentration of PCP detected in this interval was in PA-12 (64 ppm). The minimum concentration of PCP detected in this interval was in PA-11 (4.8 ppm). The concentration of both PCP and creosote constituents decreased below the Ø - 1 foot interval in each boring.

Concentrations below a depth of 2 feet were below detection for all parameters tested in PA-8 and PA-9. The PCP concentrations in PA-11, PA-12, and PA-13 had decreased to below detection in the 2 - 3 ft. interval.

2.2.2 Lagoon 2

The presence of PCP and creosote constituents in the soils of Lagoon 2 was determined by advancing two borings (SP-1.1 and SP-1.2), each to a depth of 3Ø feet. The boring locations are shown on Drawing 1. The soils were sampled in one foot intervals, and were analyzed for PCP, naphthalene, fluoranthene and acenaphthylene. A third boring (SP-1.3) was advanced and samples were collected, but the samples were not analyzed due to cost considerations. The soil analyses indicate the presence of both PCP and creosote parameters. Graphs of the analytical results versus depth are presented as Appendix E.

The highest concentrations of PCP detected in boring 1.1 occur in the uppermost eight (8) feet, with concentrations ranging from 23 ppm (4 - 6 ft. interval) to a maximum 6Ø ppm (2 - 4 ft. interval). The highest concentrations of creosote parameters in

SP-1.1 also occur in the uppermost eight (8) feet. The concentrations of both PCP and creosote constituents in SP-1.1 generally decrease with depth below eight (8) feet.

The highest concentration of PCP detected in boring 1.2 is 390 ppm (22 - 24 ft. interval). The highest concentration of creosote parameters in SP-1.2 also occur in the 22 - 24 ft. interval (370 ppm fluoranthene). The relatively high levels detected in the 22 - 24 ft. interval in SP-1.2 are not reflected in the SP-1.1 boring. This would suggest that the high values listed for this interval in SP-1.2 are possibly the result of either contamination from shallower intervals during sampling and/or errors in analysis. However, the uppermost six (6) feet of boring 1.2 and the 14 - 16 ft. sample interval are also characterized by elevated concentrations of the creosote parameters. Concentrations of naphthalene and acenaphthylene typically reflect those for PCP and fluoranthene in both borings.

2.2.3 Lagoon 3

The concentrations of PCP and creosote constituents in the soils of Lagoon 3 were determined by advancing three (3) borings (SP-2.1, SP-2.2, and SP-2.3), each to a depth of 30 feet. The locations of the SP borings are presented on Drawing 1. Soil sampling were analyzed in one (SP-2.2) or two foot intervals (SP-2.1 and SP-2.3). Analyses were for PCP, naphthalene, fluoranthene, and acenaphthylene. The analyses indicated the presence of both PCP and creosote constituents in the soil. Graphs of the analytical results versus depth are presented as

Appendix E. The analytical results for boring SP-2.1 are based on the EP-toxicity test. The PCP concentrations in SP-2.1 range from less than detection (<0.001 ppm - in the 20 through 26 ft. interval) to 1.6 ppm (in the 8 - 10 ft. interval), with the highest concentrations of 1.6 ppm in the uppermost 10 feet. The concentrations of creosote parameters in SP-2.1 are generally below the detection limit of <0.005 ppm. However, slightly elevated creosote parameters were detected in some intervals.

The highest concentrations of PCP detected in boring SP-2.2 occur in the uppermost nine (9) feet, with concentrations ranging from 2.2 ppm (in the 5 - 6 ft. interval) to a high of 170 ppm (in the 7 - 8 ft. interval). The highest concentrations of creosote parameters in SP-2.1 also occur in the uppermost nine (9) feet levels. The concentrations of both PCP and creosote constituents in SP-2.2 generally decrease with depth below nine (9) feet.

The highest concentrations of PCP detected in boring SP-2.3 were located in the uppermost six (6) feet (3.3 and 55 ppm in the 0 - 2 ft. and 2 - 4 ft. intervals, respectively). The concentrations of creosote parameters in SP-2.3 range from less than the <0.1 ppm detection limit, to a high of 130 ppm (fluoranthene). The maximum creosote concentrations are generally confined to the upper six (6) feet of the boring. The concentrations of both PCP and creosote constituents in SP-2.3 generally decrease rapidly with depth below six (6) feet.

2.2.4 Waste Pile

The soil beneath the Waste Pile was characterized based on the procedures described in the Site Geohydrological Investigation Plan (February 4, 1987) and the Sampling and Analysis Plan (February 4, 1987). Three borings were advanced in the Waste Pile area (BG-3, BG-4, and BG-5) using a truck mounted drill. The location of each boring is shown on Drawing 1. Boring BG-3 was advanced to a total depth of 6 feet, with composite samples collected at one foot intervals. Borings BG-4 and BG-5 were advanced to a total depth of 4 feet, with composite samples collected at one foot intervals. The samples were analyzed for PCP, naphthalene, fluoranthene, and acenaphthylene. Tabulated results of the chemical analyses are presented in Appendix D. Graphs of the analytical results versus depth are presented in Appendix E.

The analytical results indicate that low concentrations of PCP and creosote constituents are present. All maximum concentrations detected were in the Ø to 1 foot sample interval in each of the three (3) borings. The concentrations of each parameter tested in each of the borings decreased with depth. The highest analyte concentrations were detected in boring BG-3. PCP concentrations in BG-3 range from less than detection to a maximum of 1.7 ppm in the Ø - 1 ft. interval. Concentrations of naphthalene, fluoranthene, and acenaphthylene in BG-3 range from less than detection to 1.6, 1.Ø, and Ø.94 ppm respectively. The analytical results for BG-4 and BG-5 indicate that concentrations of the same analytes are lower than those of BG-3.

2.2.5 Sawdust Pile

The concentrations of PCP and creosote constituents in the former sawdust pile area were determined from soil samples collected from borings BG-1 and BG-2. The locations of these borings are presented on Drawing 1. The analytical results for PCP and selected creosote parameters are presented as tables in Appendix D. Graphs of the analytical results versus depth are presented in Appendix E.

The analytical results for BG-1 indicate concentrations of acenaphthylene only just above detection (<0.1 ppm) for the 18 - 20 ft. and 22 - 24 ft. intervals in BG-1 (0.11 and 0.12 ppm respectively). All other intervals were below detection for all parameters tested.

The analytical results for BG-2 indicate concentrations of naphthalene (0.40 ppm) and acenaphthylene (0.24 ppm) were present in the 20 - 22 ft. and 20 - 22 ft. intervals respectively. All other intervals in BG-2 were below detection for all parameters tested.

The lack of near surface detections for the selected analytes and the extremely low levels detected for acenaphthylene and naphthalene at depth suggest that the sawdust pile has not contributed to the presence of wood-treating constituents detected in either the soils or the ground water at the subject site.

2.3 GROUND-WATER HYDROLOGY

2.3.1 Piezometers

Data from the Preliminary Site Investigation report (1988) was used to establish locations for the piezometer nests and the intervals in which the wells were to be completed. Each "sandstone" member illustrated in the Preliminary Site Investigation report was subsequently assigned an ad hoc designation. The units were labeled alphabetically and in ascending order with the basal sand unit being designated as "A". The alphabetic labels were then used to indicate the interval in which a well was to be completed. For example, well P-4C was to be completed in interval C at piezometer location 4.

Three (3) intervals were targeted for investigation and were designated A, C, and D.

Although the well completion intervals selected in the field appeared to correlate with the intervals targeted using the Preliminary Site Investigation report, it was decided to verify the correlations using borehole geophysical logs. Subsequent correlation of the geophysical logs revealed that some of the wells did not correlate with their original targeted intervals. Details discussing the relationship between well intakes and the intervals in which they were completed are presented in the Piezometer Installation report dated April 30, 1990.

2.3.2 Aquifer Characterization

2.3.2.1 Water-level Monitoring

Data for water-level evaluation were obtained in two (2) distinct phases. The first phase occurred as weekly measurements over an eight (8) week period beginning November 21, 1989. Data resulting from these measurements were used to develop the potentiometric surface contour maps and initial evaluation of aquifer response to precipitation presented in the Piezometer Installation report (1990). A second phase of water-level measurements was initiated upon implementation of the ground-water sampling program. Depth to water measurements were taken before each of the six (6) ground-water sampling events. The second phase of water-level data acquisition began April 2, 1990 and continued until February 12, 1991. The intent of the water-level monitoring activity was to observe formation response to precipitation events, and to establish any seasonal trends in water-level fluctuations.

All water-level measurements were obtained using an electric wireline and recorded to the nearest 0.01 foot. The measurement point for each well is the top of the PVC well riser. The location and elevation for each well has been established by a registered surveyor. Well locations at the site are presented as Figure 2.3.

Depth to water measurements were converted to water-level elevations and are presented as Table 2.1. Intervals in which the wells had been completed were correlated using borehole geophysical logs and lithologic information obtained while drilling. The appropriate wells for an interval were then used to develop the potentiometric surface map for that interval. A conceptual water-table configuration map was also developed. The water-table configurations were developed using the water-level elevation from the shallowest well at each of the five (5) well nests.

Well hydrographs for each of the well nests have been prepared using water-level data obtained during the entire water-level monitoring period (see Appendix F). All hydrograph signatures demonstrate the same overall trends in water-level elevation. Water-level elevations for wells completed in the A interval tend to be highest in April and lowest in August. Shallower wells tend to have their highest water-level elevations in June and their minimum elevations in October. The exceptions to this pattern are MW-5C and 5D which parallel the MW-5A signature, and MW-4D which achieved its highest water-level elevation in April.

Response of the ground-water system to local precipitation events is evidenced when well hydrographs are compared with the weekly precipitation histogram presented as Figure 2.4. The lower precipitation and higher evapotranspiration rates of summer are clearly reflected in all of the well hydrographs.

2.3.2.2 Flow Patterns

Water-level elevation contours indicate the wood treatment facility to be situated on an area of ground-water recharge. A ground-water divide trending east west along the axis of the topographic high upon which the facility is situated is the dominant ground-water feature. This divide is persistent throughout the year and is present in all subsurface intervals under investigation. Head differentials between nested wells at each location indicate that a downward vertical flow component exists throughout the year at all locations except as noted:

MW-4: January, 1990 event when ground-water elevation in MW-4D is greater than elevation in MW-4G.

MW-6: January and October, 1990 events where ground-water elevation in MW-6A is greater than elevation in MW-6C.

The horizontal directions of ground-water flow at the site are to the northeast, east, southeast, south, and southwest. The Process Area is situated near the east end of the ground-water divide. The direction of ground-water flow beneath the Process Area shifts during the year. Changes in ground-water flow direction relative to the Process Area are illustrated in the potentiometric surface maps presented as Volume II of this report. Ground-water flow beneath Lagoons 2 and 3 is invariably to the northeast.

2.3.2.3 Hydraulic Conductivity and Ground-Water Flow Rates

Due to the stratified nature of the Antlers Sandstone, three (3) intervals in the formation were to be subjected to 72 hour pumping tests as proposed in the Site Geohydrologic Investigation Plan dated February 4, 1987. These tests were to be performed in an effort to determine hydraulic conductivity (K) values and evaluate the potential for vertical communication between intervals. However, a preliminary evaluation of the formation using the four-inch diameter wells at MW-2A, D and E indicated that 72 hour pumping tests would not be feasible. Therefore, the four-inch diameter wells were subjected to "slug" type yield testing instead of the proposed 72 hour pumping tests. Details on the procedures employed in performing the yield tests and data analysis were presented in the April 30, 1990 Piezometer Installation report.

Hydraulic conductivity (K) values derived from the yield testing were calculated to be 4.07×10^{-4}, 4.95×10^{-4} and 5.34×10^{-4} cm/s for intervals A, D and E respectively.

Darcian and seepage velocities were estimated using hydraulic conductivity values obtained from slug test analyses and representative hydraulic gradients in two (2) directions for each of the two intervals D and A. Maximum and minimum gradients observed since implementation of the ground-water sampling program were selected for both intervals in order to establish a range of velocities. The location and direction of the selected hydraulic gradients are depicted on the Potentiometric Surface

Contour Maps in Volume II of this report. Gradients for ground-water flow to the south involve inferred contours. Velocities calculated using these gradient values are presented only as representative estimates.

The Darcian velocities were calculated from v = K dH/dL, where K is the hydraulic conductivity determined from slug test analyses and dH/dL is the hydraulic gradient determined graphically from the distribution of potentiometric surface contours. Average seepage velocities are obtained using a porosity value of 0.30 such that a Darcian volume of water per unit area is assumed to be migrating through approximately 30 percent of the given cross-sectional area.

Table 2.2 presents estimated maximum and minimum Darcian and seepage velocities for geologic intervals A and D. The velocities presented in Table 2.2 were calculated based upon hydraulic gradients established from water-level data obtained at the Thomason site between April 2, 1990 and February 12, 1991. Ground-water velocities presented in the Piezometer report (1990) were determined to have been incorrect and are an order of magnitude too high. Table 2.2 in this report supersedes the previous (1990) calculations.

2.3.2.4 Determination of Uppermost Aquifer

Data from the Preliminary Site Investigation report (1988) originally suggested that the base of the uppermost aquifer is the top of a clay unit located 20 to 30 feet above the base of the Antlers Sandstone. The clay unit designated as the base of the uppermost aquifer in the 1988 preliminary report correlates with the clay unit separating the "B" sandstone unit from the "C" sandstone unit as illustrated in the cross-sections presented as Appendix B of this report. This clay unit is described as being grey to dark grey, silty to sandy, and dry to slightly damp.

Although there is often a substantial difference in water-level elevations between sandstone units, and a slight offset in hydrograph signature trends, all of the well hydrograph signature are essentially identical. Recharge areas for the different sandstone units are represented on the potentiometric surface maps as ground-water highs. Each of the recharge areas tends to be located in the same approximate area. However, recharge areas for intervals above this clay unit have demonstrated a slight shift to the east during the spring (April, 1990 and February, 1991) which does not appear in the "A" interval below this clay. This would indicate that the formation is acting under water-table or leaky confined conditions, and that the entire saturated thickness of the Antlers Sandstone is essentially one aquifer.

However, the clay interval between the B and C sandstone unit does appear to be successful in isolating the underlying basal sandstone units (A and B) from the wood treating constituents detected above it. Therefore, Thomason proposes that the top of the clay unit between sandstone units C and B be considered the bottom of the uppermost aquifer for closure and post-closure ground-water monitoring purposes.

2.4 Ground-Water Quality

2.4.1 Monitoring Wells

Potential contaminant source areas at the site were considered when locations for the piezometer nests were selected. The same conditions and specifications required for drilling and installing ground-water monitoring wells were employed in constructing the piezometers.

The piezometers were administratively designated monitoring wells upon implementation of the Ground-Water Sampling and Analysis Plan (199Ø). Details regarding well design, installation, and development, etc. are presented in the Piezometer Installation report (199Ø). Well construction records are presented as Appendix C of this report.

2.4.2 Ground-Water Sampling

Samples of ground water were removed from each well, transported and analyzed in accordance with the Ground-Water Sampling and Analysis Plan dated February 23, 199Ø and modified in the Piezometer Installation report dated April 2Ø, 199Ø. Duplicate samples, equipment, field, and trip blanks were the basis of the QA/QC program. Laboratory reports and a listing of the sample locations for each ground-water sampling event have been submitted to the U.S. EPA and OSDH as required. Chemical data from all monitoring wells have been tabulated for each event, and are presented in this report as Appendix G.

2.4.3 Statistical Evaluation

2.4.3.1 Selection of Statistical Method

Five (5) different statistical methods appropriate to ground-water monitoring meet the requirements presented in 40 CFR Part 264. The five (5) methods approved by the EPA are: Analysis of Variance, Tolerance Intervals, Prediction Intervals, Control Charts, and any other statistical test method submitted by the owner (or operator) which is subsequently approved by the EPA Regional Administrator.

Three of the four statistical evaluation techniques presented by the EPA in 40 CFR Part 264 require a comparison of sampled down-gradient monitoring well data to background monitoring well data. The Control Chart statistical method is the only method proposed by the EPA which does not require a comparison between background monitoring well data and the data gathered from other sampled monitoring wells. Control Charts can be constructed for each constituent in a given well over time. A control chart may then be used to monitor the inherent statistical variation of the data collected, and to flag anomalous results. The mean analyte concentration for subsequent new samples for a given well can be compared to the historical data from that well. Conclusions may then be drawn regarding whether the well is in "control".

The Control Chart method was selected for use in evaluating the ground-water quality data. This approach allows the evaluation of each well based upon its own historical data. Therefore, the statistical evaluation for a well would not be degraded by the removal of other wells from the ground-water monitoring system or the loss of "up-gradient/background" wells at the site.

2.4.3.2 Application of Statistical Method

Control charts for total PNA's (acenaphthylene, fluoranthene, and naphthalene) and PCP concentrations were established in order to provide some systematic significance for current and subsequent data.

A control envelope was calculated for each ground-water monitoring well. It was assumed that each well represents its own universe of conditions and that there were no assignable causes for the variation in concentrations in the current data base. The mean value of analyte concentration for a given well at a given time was determined using either the average of duplicate samples, or the value of the analyte concentration itself if only one value per sampling event exists. Concentration values of less than detection were assigned a value of 1/2 the detection limit for statistical calculations. The mean of these concentration mean values for each well through time was calculated and considered to represent the mean of the "universe". The standard error of the mean was calculated (ignoring the correction for a finite universe) for each well with a universal mean value. A confidence limit of plus or minus three standard errors was then determined, as is prevalent in statistical quality control in the United States. The probability of a sample falling outside the three standard error confidence limit is so small that it is considered almost certain that a sample will fall within the plus or minus three standard error limit from the mean of the universe, where the mean plus three standard errors is the upper control limit (UCL) and the mean minus three standard errors is the lower control limit (LCL).

Table 2.3 shows the sampling frequency, mean, standard deviation, variance and standard error of the mean for all wells in the ground-water quality monitoring program. Table 2.4 presents calculated upper and lower control limits for those wells listed in Table 2.3. The detection limit itself is used as the lower control limit when the calculated lower limit is less than the detection limit.

Time series charts showing the estimates of the universal mean value (MV), the upper and lower limit of the confidence interval, and the mean of each detectable analyte are presented as Appendix H. These charts can be used to determine whether the variation of each sample mean from the universal mean value can be attributed to either random (within the confidence interval), or assignable causes (outside the confidence interval). When an assignable cause is believed to have caused the variation the process is considered "out of control". If only random variations are present the process is "in control".

2.4.3.3 Statistical Trend in Water-Quality Data

The determination of trends in the water-quality data using statistical methods is not meaningful at this time. Water-quality data for all six (6) sampling events have been employed in developing a "historical" control chart for each well. This "historical" control chart is intended for use in evaluating water-quality data from subsequent ground-water sampling events.

2.4.4 Graphical Evaluation

Graphs illustrating detected analyte concentration values versus time are presented as Appendix I. Analyte concentration graphs were prepared for all monitoring wells which have been sampled. Data from duplicate samples are presented as averaged values. If one sample of a duplicate data set was less than detection, the detection limit was used in calculating the average for the two (2) values. The detection of an analyte is represented by the appropriate letter symbol placed at the corresponding concentration level. If an analyte was not detected on a date during which a well was sampled, the symbol for that analyte was not plotted. Water-quality data from subsequent ground-water sampling events will be added to each graph as data become available. Direct comparison of analyte concentrations between well locations is possible through the use of a logarithmic scale.

The trend in PCP detection appears to be cyclic. The cyclic nature of the detected analyte plots for PCP indicates that low concentrations of wood preservative constituents are apparently entering the ground-water system on an intermittent basis. The highest concentrations of PCP in ground water have been detected in MW-6C. This would indicate the apparent source area for PCP to be closest to MW-6C. A comparison between well hydrographs, PCP concentration data for MW-6, and precipitation data suggest that wood treating constituents enter the ground-water system as precipitation infiltrates through soils underlying Lagoon 3. The seasonal nature of these events in reflected by the two PCP concentration peaks for MW-6C. One peak occurs in spring and the other occurs in late fall. Minimum PCP concentrations in MW-6C occur at the beginning of the summer dry period. Signature for PCP detection in MW-2D and 4D indicate the PCP peak in spring is approximately twice as long as the fall peak and is approximately the same concentration. This relationship is apparently due to the more prolonged and intense spring precipitation. Fall precipitation is shown to be less frequent and of lower intensity than that of spring. These graphs also illustrate that the maximum concentrations of PCP likely to be detected in the ground-water are less than Ø.4 mg/l.

Maps illustrating the spatial distribution of detected analytes are presented as Appendix J. Wells in which no analytes were detected have no data presented. Data pairs are presented for wells from which duplicate samples were obtained. It may be seen from these maps that wood treating constituents in ground-water have been encountered primarily in interval D. No detections have occurred in MW-2E or MW-4G. This would suggest that wood treating constituents are not entering the ground-water system from either the Process Area, Waste Pile Area or the non-saturated soil beneath or Lagoon 2.

3.0 REGULATORY LIMITS

3.1 Summary

The relatively low concentrations of wood preservative constituents (PCP and selected creosote parameters) in the soil and ground water beneath the site area, in conjunction with other site specific factors, suggest that an imminent threat to health or the environment does not exist at the site. Site sample analyses have been compared to published and/or proposed action levels and other regulatory guidelines. The regulatory action limits identified in the following sections are based on published and proposed concentrations used by the EPA in both the RCRA and NPDES regulations.

3.2 Soils

Appendix A of the EPA Proposed Corrective Action Rule for Solid Waste Management Units (55 FR 30798; July 27, 1990) provides action limits for soils contaminated with PCP at 2,000 mg\kg. The highest concentration of PCP in soils at the Thomason site is 390 mg\kg at 22 - 24 ft. in boring 1.2 (Lagoon 2). The EPA proposed criteria for action limits, in conjunction with the closure of the Waste Pile and Lagoons 2 and 3, remediation of Lagoon 1 (Resource Recovery Area), and other remediation activities at the site, indicate that the concentrations of PCP in the soil at the site do not present an imminent threat to health and the environment.

The proposed rule does not contain action limits for creosote or any of the creosote parameters tested. A documents search, including IRIS, revealed that no soils action limits for creosote or creosote parameters tested currently exist. Action limits identified for creosote parameters not tested (e.g., cresols and phenol) indicated action levels to be at least an order of magnitude greater than the levels of acenaphthylene, naphthalene and fluoranthene detected at the subject site.

3.3 Ground Water

Appendix A of the EPA Proposed Corrective Action Rule for Solid Waste Management Units provides action limits for water containing PCP at 1.0 mg\l. The highest concentration of PCP detected at the subject site was 0.3 mg\l (Lagoon 3 area (MW-6C)). All detected concentrations in the ground-water at the site are below the proposed action limit. Most ground-water samples from the site are consistently below the detection limits for all of the selected analytes.

The U.S. EPA published water quality and human health criteria in the Quality Criteria for Water, 1986. The document contains available data for fluoranthene which indicate that acute toxicity to freshwater aquatic life occurs at concentrations of 3.98 mg\l. The document does not contain data concerning the available chronic toxicity of fluoranthene to sensitive freshwater aquatic life. The document also contains data for acute (2.3 mg\l) and chronic (0.62 mg\l) toxicity to freshwater aquatic life for naphthalene. Appendix A of the EPA Proposed Corrective Action Rule for Solid Waste Management Units does provide action limits for cresols (2 mg/l) and phenols (20 mg/l).

The analytical results of ground-water samples collected from wells MW-5D and MW-6C indicate the maximum concentrations of both fluoranthene and naphthalene detected at the site are well below the concentrations for these parameters established by the EPA for water discharges under the NPDES program.

4.0 WELL SURVEY AND GROUND-WATER USAGE

A hydrogeologist from B & F Engineering conducted a well survey for all identifiable water supply wells within a 1600 feet radius of the facility. Driller's logs and well permit records for these wells were not available from the Oklahoma Water Resources Board (OWRB). Information regarding water wells was obtained by going door to door and speaking with residents while noting the wells in the area. If a well was observed it was noted even if no data about the well could be acquired. Eight (8) wells were located within a 1,600 ± ft. radius of the Process Area. Table 4.1 presents a summary of the data acquired during the survey. Drawing 3 depicts the locations of wells located during the survey.

Only three (3) wells identified in the survey were in use. One well was reported by the owner to have "good" water and a second reported to have poor water quality ("tastes bad"). The third well (location 5) was new and was just being placed into use. All three (3) water-wells in use are located west and southwest of the facility. Two (2) of the wells noted during the survey had been abandoned, and at the time of the survey were being used as trash receptors. No water wells down-gradient of the closed lagoons were discovered during the survey.

Ground-water usage in the study area is apparently quite limited. Most of the wells are shallow, dug wells located upgradient of the facility. These wells are not likely to be impacted upon by the very low levels of wood treating constituents detected in the ground-water beneath the subject site. Therefore, there is no imminent threat to public health from the wood preservative constituents detected in the ground-water at the Thomason Facility.

5.0 SUMMARY

Lack of analyte detection in ground-water samples from MW-2E and MW-4G suggests that neither the Process Area, the Waste Pile Area, nor recharge through Lagoon 2 is contributing to the presence of detected analytes in the ground-water system. The source of detected analytes in the ground-water system appears to be the result of recharge to the ground-water system by infiltration of precipitation through the soils beneath Lagoon 3.

Detection of wood preservative constituents in MW-2D and 4D appear to be the result of Dense Non-Aqueous Phase (DNAP) movement of wood-treating constituents down dip along interval D. Detections in MW-5D are potentially a combination of DNAP movement, and leaching of wood-treating constituents from soils in the phreatic zone beneath Lagoon 2.

The detection of a creosote indicator in MW-2D, 5D, and 6C has always been accompanied by the detection of PCP. Therefore, the only detection in MW-1CD, which was the only detection of fluoranthene in ground-water and is without the detection of PCP, would appear to be suspect. No creosote indicators have been detected in MW-4D.

Analytes detected in the ground-water system appear to be restricted to the eastern portion of the site. The lack of detections in MW-5C, and all the "A" interval wells indicate the detected analytes in ground-water to be restricted to a narrow interval within the aquifer.

The low levels of concentrations detected in the soil and ground-water, along with the absence of water wells down-gradient of the site suggest that there is no imminent threat to human health. Thomason, therefore, proposes that the levels of wood treating constituents detected in the ground-water system are not significant and that the ground-water sampling program presented in Section 10 I of the Consent Agreement is not warranted at this time.

6.Ø RECOMMENDATIONS

Thomason Lumber and Timber Company proposes the following actions based upon the data acquired during its site investigation.

1. Capping the Lagoon 2 and 3 areas using a hybrid cap employing both clay and flexible membrane liners (See Closure Plan (1991) for these units.

2. Ground-water monitoring employing monitoring wells MW-1CD, MW-2D, MW-4D, MW-5D, and MW-6C. Monitoring of these wells is to be on a quarterly basis until December, 1991, or until approval of the Closure Plan dated May 31, 1991, whichever occurs earlier. These data will be retained until the first annual report. These data will be used to refine the control charts used in evaluating subsequent (Post-Closure) monitoring.

3. Implementation of the Closure Plan will require the monitoring of the wells listed in item 2 on an annual basis. Monitoring of these wells is to be performed during the eight (8) week period between March 1, and April 3Ø of the reporting year.

4. Annual reports are to be received by the EPA and OSDH on, or before March 1 of the following year.

5. Annual reports are to include the following:

    a. Potentiometric surface maps for all intervals as have been previously reported.

    b. Water-quality analytical data.

    c. Statistical evaluation employing the control charts developed using pre-remediation data.

6. At five (5) year intervals, a report evaluating ground-water trends and the effectiveness of selected remediation measures be received by the EPA and OSDH no later than March 1 of the following year.

7. Five (5) year reports are to include the following:

    a. Annual report for the fifth year is described in Section 5 above.

b. New control charts for statistical evaluation of subsequent water-quality data. The new control charts will be developed by incorporating data from the previous five (5) years, and will be utilized to evaluate the data acquired in the subsequent five (5) years.

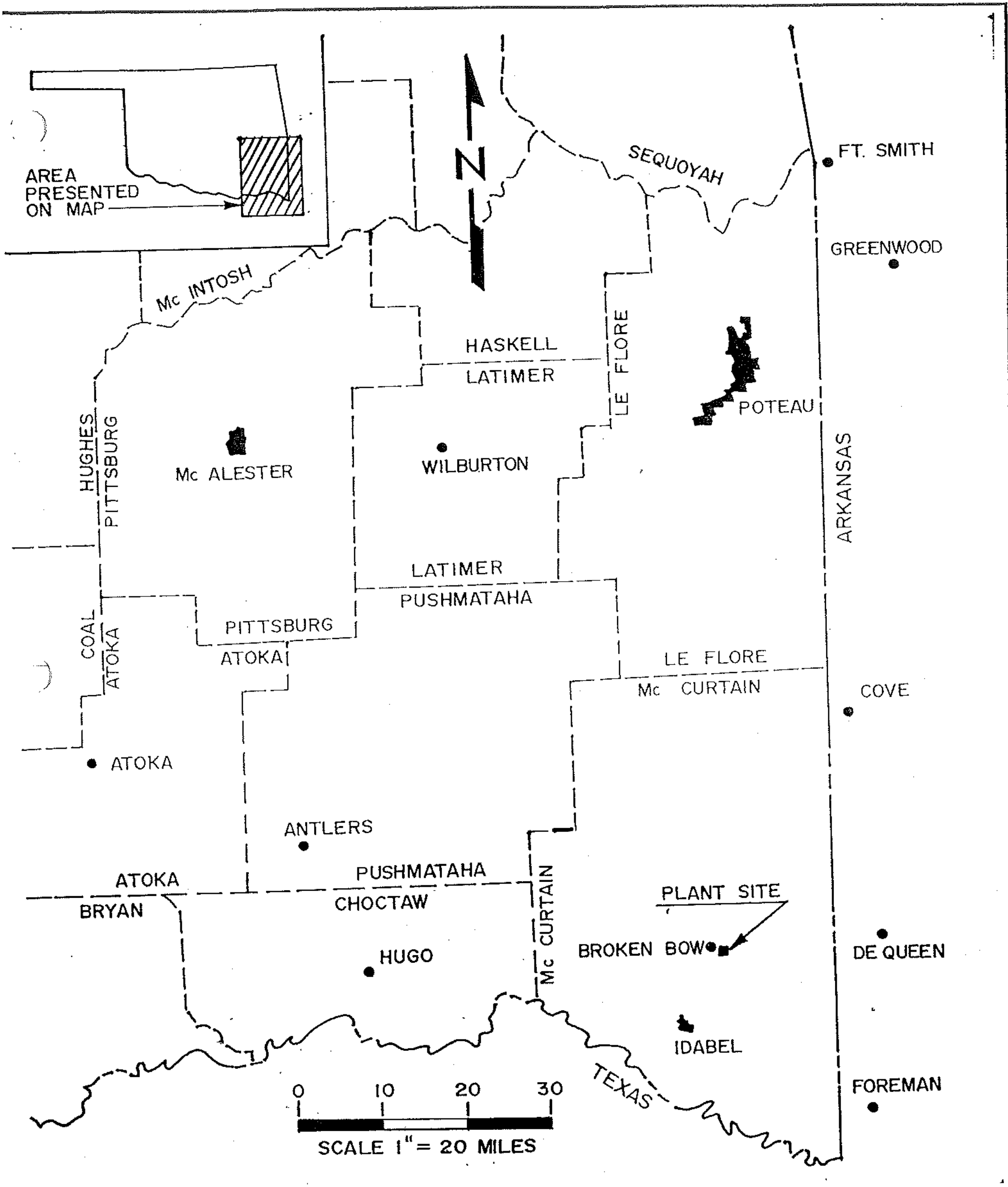
c. Trends in ground-water data, and evaluation of the selected remediation measures.

d. Recommendations regarding continuance of the ground-water monitoring program.

8. Ground-water monitoring is proposed for a maximum period of thirty (30) years.

9. Analytes for ground-water monitoring are to be PCP, acenaphthylene, fluoranthene, and naphthalene.

10. Lack of detection in a well for two (2) successive years will be grounds for discontinuance of monitoring in that well.

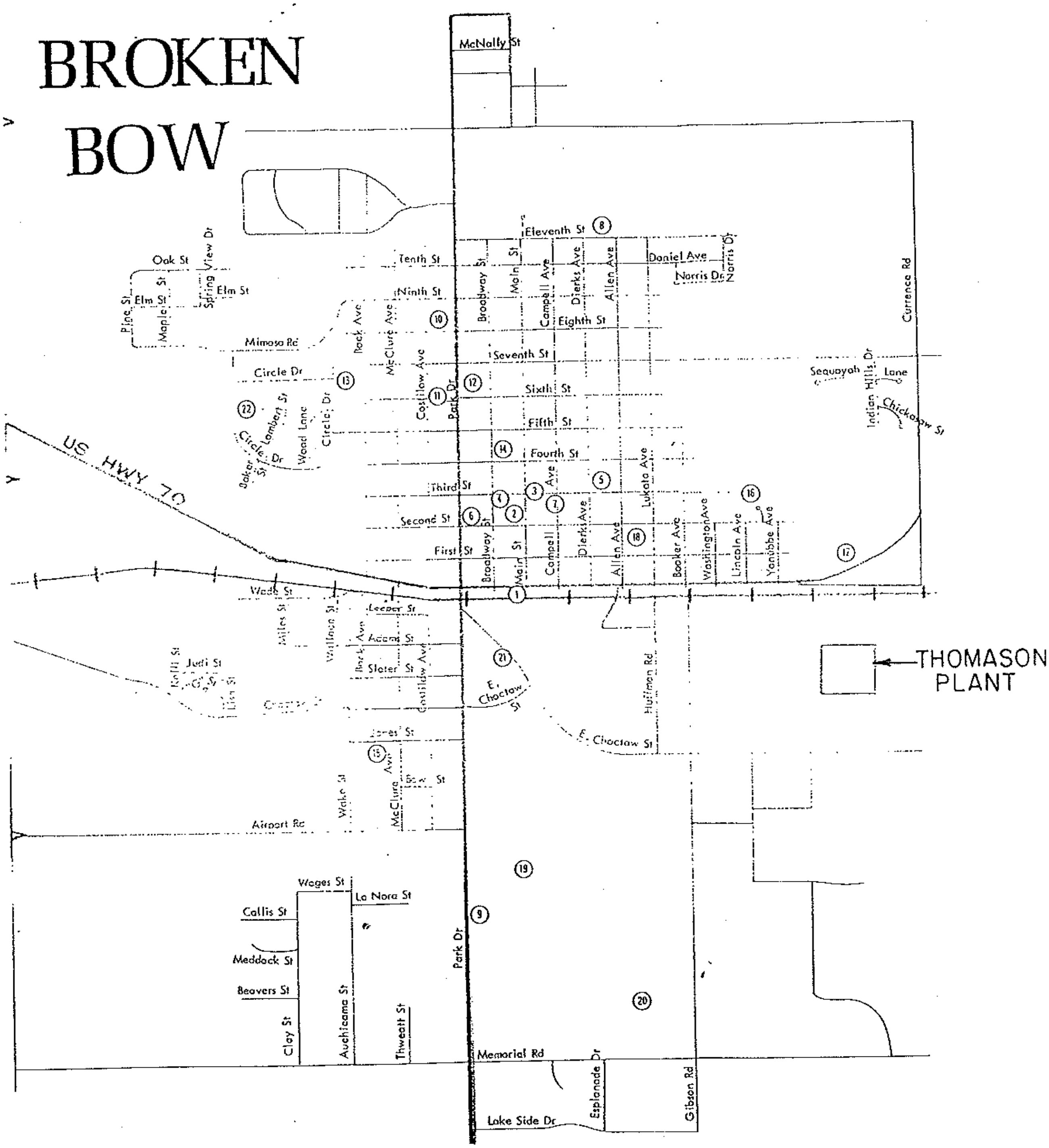


wn.		
k.		
pproved:		

B&F ENGINEERING, INC.
928 AIRPORT RD., HOT SPRINGS, ARK. 71913 • 767-2366

FIGURE 1.1
REGIONAL LOCATION MAP
THOMASON LUMBER & TIMBER COMPANY
BROKEN BOW OKLAHOMA

DWG. NO.
SCALE: N.T.S.
DATE: MAY, 1991
BK. NO.



			B&F ENGINEERING, INC. 928 AIRPORT RD., HOT SPRINGS, ARK. 71913 • 767-2366	DWG. NO.
Dwn.			FIGURE 1.2 PLANT VICINITY THOMASON LUMBER & TIMBER COMPANY	
Ck.				SCALE: N.T.S.
Approved:				DATE: MAY, 1991
			BROKEN BOW OKLAHOMA	BK. NO.

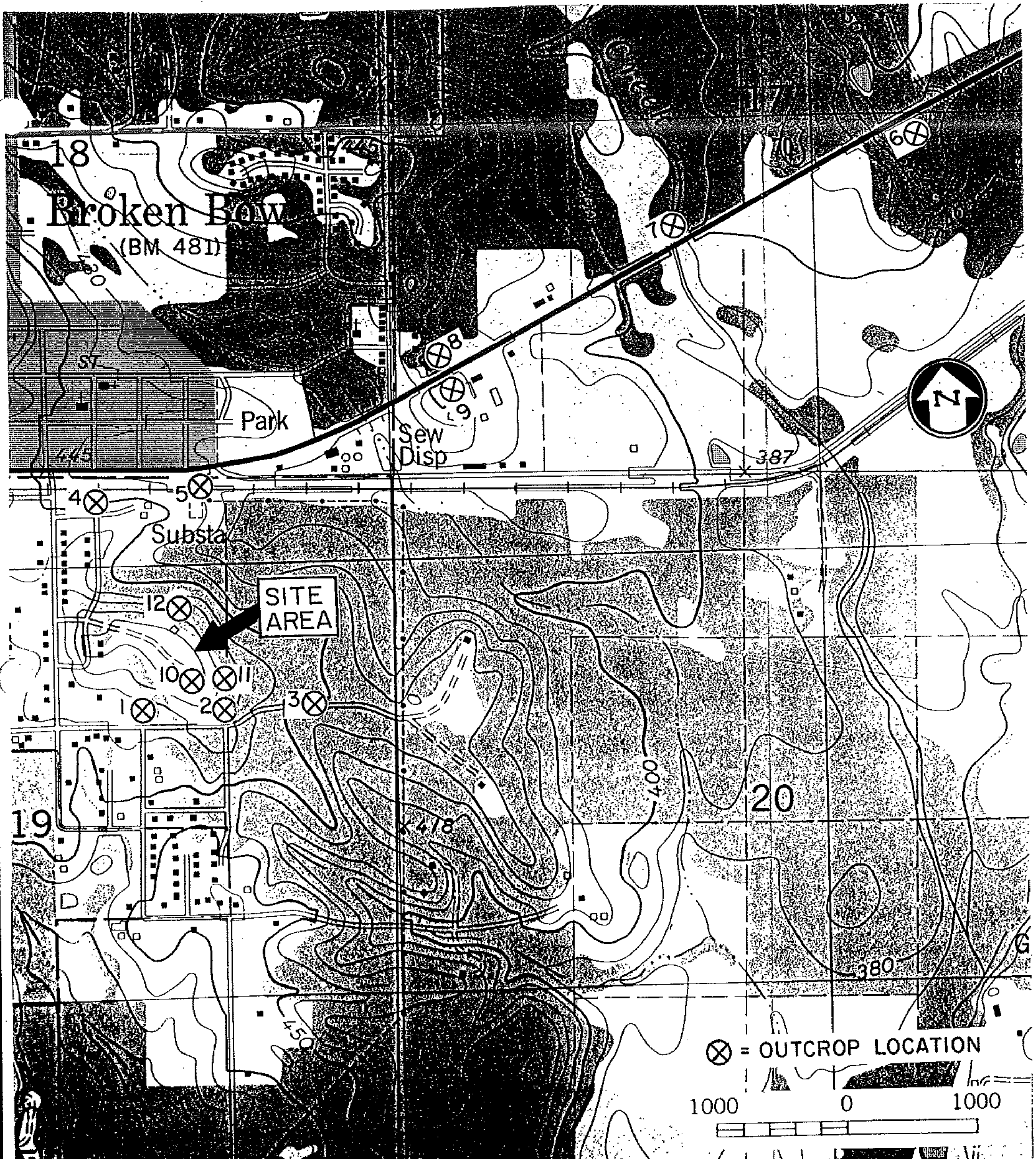


FIGURE 2.1

Surv.			B&F ENGINEERING, INC. 928 AIRPORT RD., HOT SPRINGS, ARK. 71913 • 767-2366
Dr.	CAF	5/91	
Ck.	JVO	5/91	OUTCROP LOG LOCATION MAP
Approved:			THOMASON LUMBER & TIMBER CO.
			BROKEN BOW — OKLAHOMA

DWG. NO. 7-2397-0101

SCALE: 1" = 1000'

DATE: MAY, 1991

BK. NO.

Hall 6053

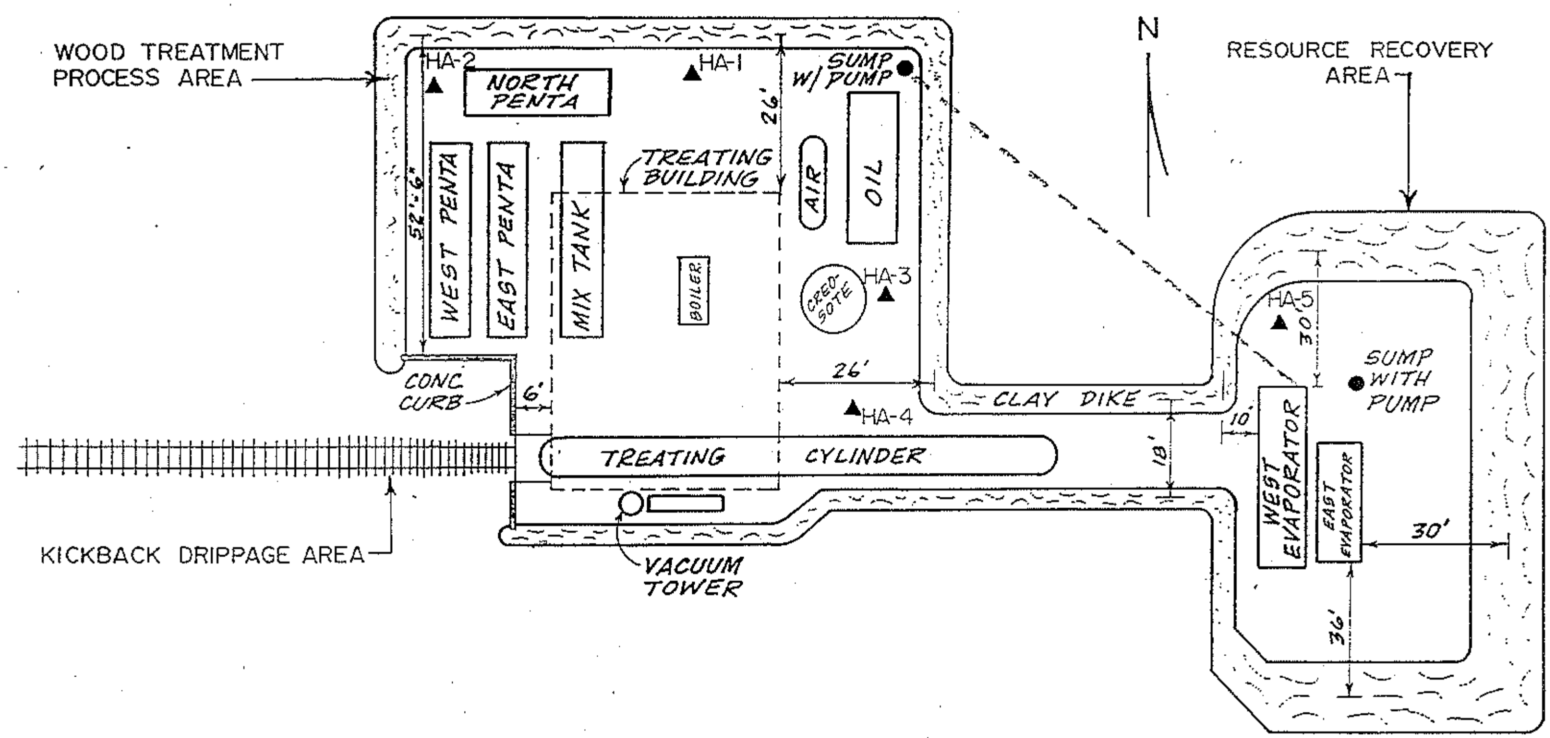


FIGURE 2.2

B&F ENGINEERING, INC.
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(501) 767-2366

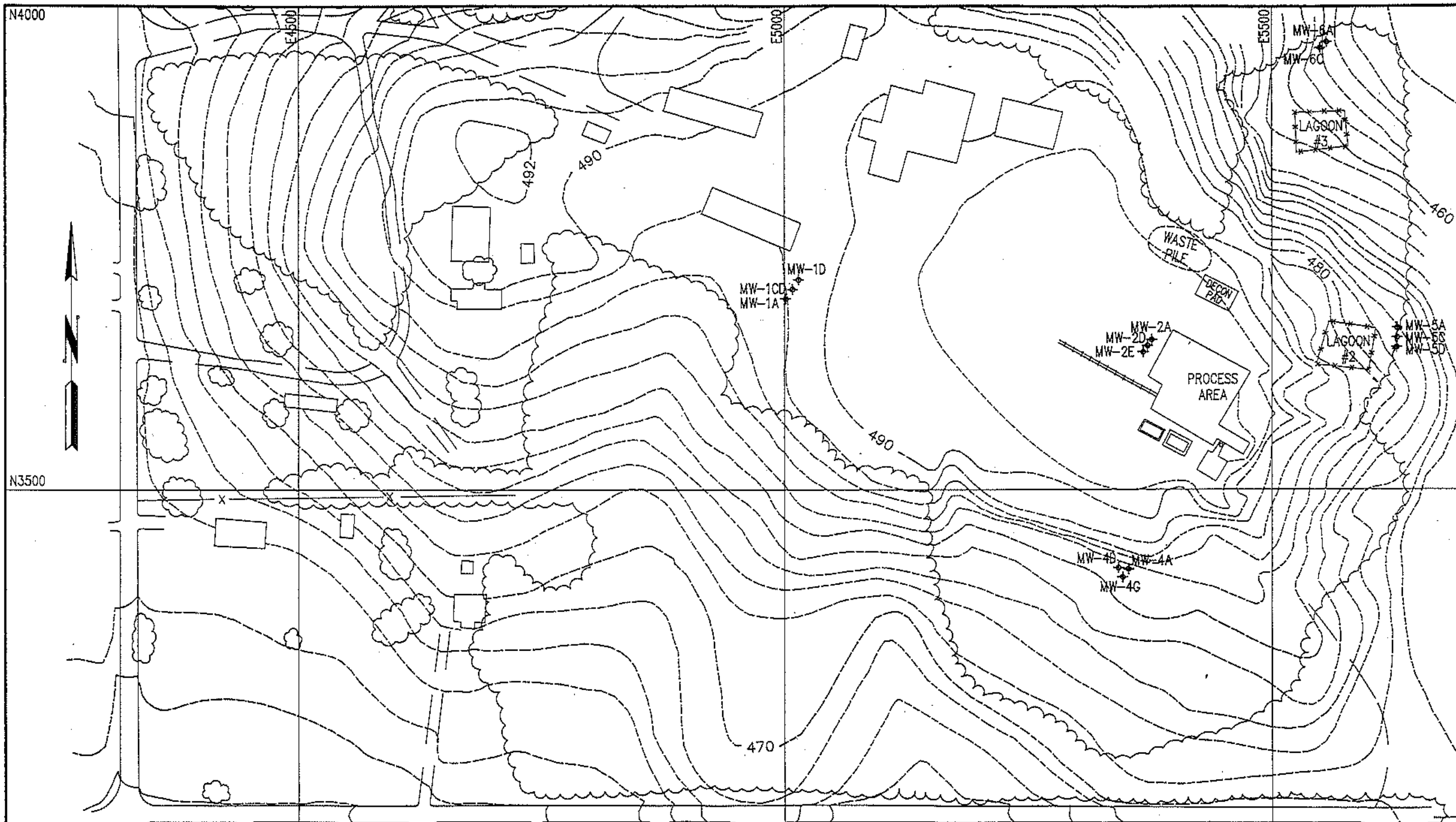
DWG. NO. 7-2397-0101

HAND AUGER (HA) SOIL SAMPLE LOCATIONS

THOMASON LUMBER & TIMBER CO.

BROKEN BOW OKLAHOMA

Dwn. JKH
Ckd. PWB
SCALE: 1"=20' APRX.
DATE: MAY, 1991



	BY	DATE
Design		
Drawn	JKH	05/91
Checked	PWB	05/91
Survey		
Fld.Bk.No.		

B&F ENGINEERING, INC. 928 AIRPORT ROAD, HOT SPRINGS, ARKANSAS 71913
(501) 767-2366

FIGURE 2.3
MONITORING WELL LOCATION MAP
THOMASON LUMBER AND TIMBER COMPANY
BROKEN BOW OKLAHOMA

05/30/91
JOB NO.: 7-2397-0101
ACAD NO.: 075
SCALE: 1" = 100'
DATE: MAY, 1991

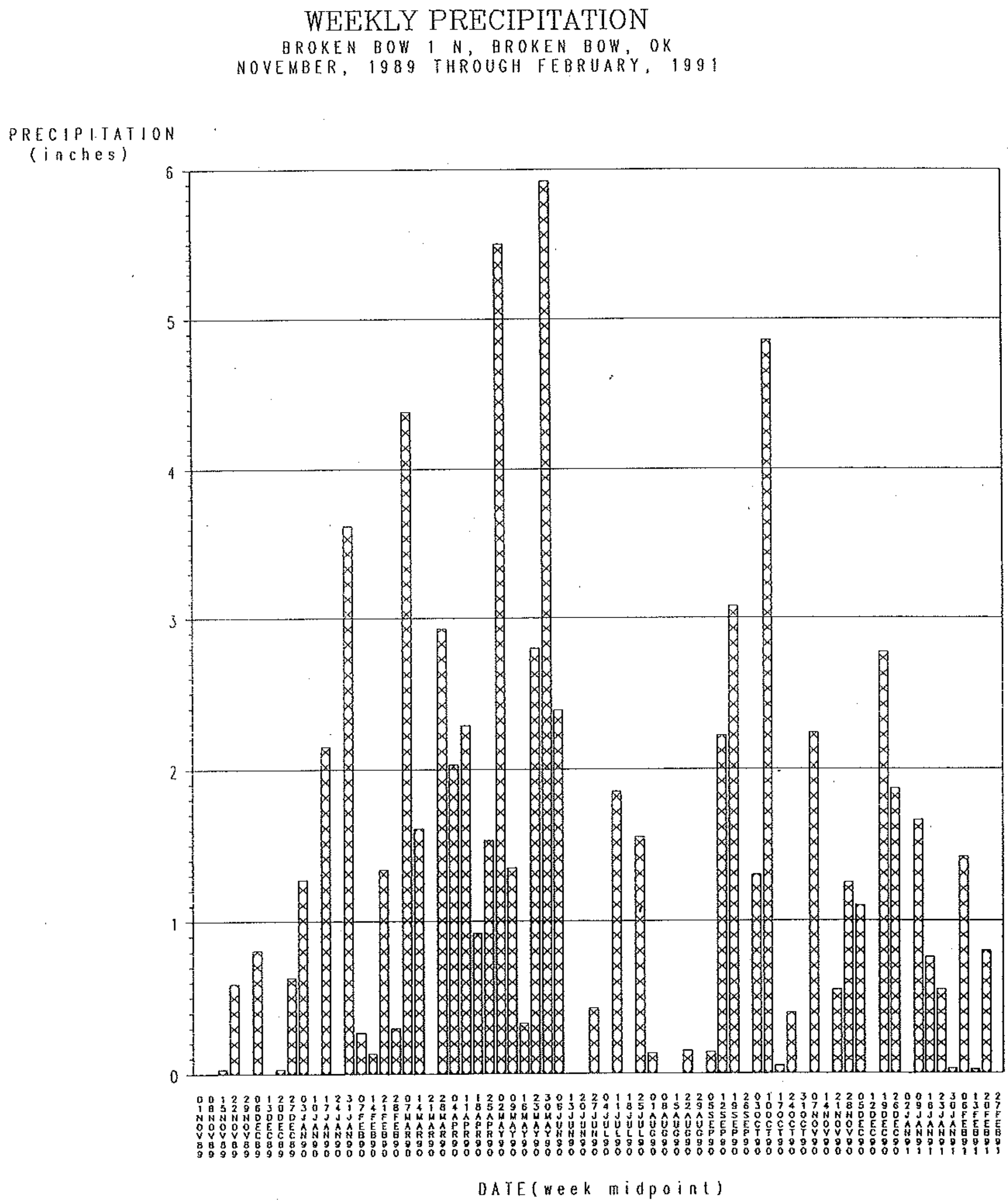

WEEKLY PRECIPITATION
BROKEN BOW 1 N, BROKEN BOW, OK
NOVEMBER, 1989 THROUGH FEBRUARY, 1991
PRECIPITATION (inches)
0
1
2
3
4
5
6
DATE(week midpoint)

FIGURE 2.4

WELL INFORMATION					WATER LEVEL APR. 2, 1990		WATER LEVEL JUN. 19, 1990		WATER LEVEL AUG. 20, 1990		WATER LEVEL OCT. 17, 1990		WATER LEVEL DEC. 17, 1990		WATER LEVEL FEB. 12, 1991	
WELL LOCATION	INSTALLATION DATE	GROUND SURFACE (WELL PAD) ELEVATION (FT.MSL)	MEASUREMENT REFERENCE POINT ELEVATION (FT.MSL)	INSTALLED DEPTH FROM REF.PT. (FEET)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)	DEPTH FROM REFERENCE POINT (FEET)	WATER SURFACE ELEVATION (FT.MSL)
MW-1A	13 OCT 89	490.27	491.53	87.64	40.94	450.59	40.96	450.57	44.32	447.21	44.07	447.46	43.55	447.98	40.99	450.54
MW-1CD	5 OCT 89	490.69	492.12	69.61	38.97	453.15	37.64	454.48	40.51	451.61	41.30	450.82	41.08	451.04	38.87	453.25
MW-1D	5 OCT 89	490.95	492.23	58.30	38.57	453.66	36.93	455.30	39.61	452.62	40.53	451.70	40.23	452.00	38.21	454.02
MW-2A	8 OCT 89	494.42	495.79	99.35	48.37	447.42	49.44	446.35	53.34	442.45	52.35	443.44	51.41	444.38	48.59	447.20
MW-2D	12 OCT 89	494.46	495.89	64.58	41.48	454.41	40.82	455.07	44.17	451.72	44.55	451.34	44.07	451.82	41.50	454.39
MW-2E	13 OCT 89	494.61	495.92	55.38	41.51	454.41	40.75	455.17	43.98	451.94	44.56	451.36	44.01	451.91	41.50	454.42
MW-4A	12 SEP 89	483.16	484.55	100.90	37.88	446.67	39.02	445.53	42.96	441.59	41.89	442.66	40.79	443.76	37.90	446.65
MW-4D	19 SEP 89	483.18	484.55	63.38	30.35	454.20	30.54	454.01	34.25	450.30	35.57	448.98	33.84	450.71	30.82	453.73
MW-4G	26 SEP 89	482.93	484.03	45.31	29.09	454.94	28.74	455.29	32.70	451.33	32.81	451.22	32.16	451.87	29.16	454.87
MW-5A	15 OCT 89	479.38	480.82	88.48	33.64	447.18	35.44	445.38	39.74	441.08	38.56	442.26	37.23	443.59	34.38	446.44
MW-5C	18 OCT 89	479.67	481.21	64.81	30.28	450.93	31.50	449.71	35.60	445.61	34.89	446.32	33.81	447.40	30.92	450.29
MW-5D	18 OCT 89	479.86	481.39	52.58	27.42	453.97	27.82	453.57	31.43	449.96	31.48	449.91	30.63	450.76	27.88	453.51
MW-6A	10 SEP 89	458.19	459.55	47.47	13.39	446.16	15.06	444.49	19.10	440.45	18.09	441.46	16.71	442.84	14.46	445.09
MW-6C	11 SEP 89	458.40	459.84	28.85	12.22	447.62	11.80	448.04	17.45	442.39	17.57	440.83	16.54	443.30	13.56	446.28

JOB NAME THOMASON LUMBER AND TIMBER COMPANY

JOB NUMBER 7-2397-0101 ACAD NO. 057 05/09/91

B&F ENGINEERING, INC.

TABLE 2.1
WATER LEVEL DATA
APR. 2, 1990 – FEB. 12, 1991

TABLE 2.2

ESTIMATED GROUND-WATER VELOCITIES
FOR GEOLOGIC INTERVALS A AND D
(MAXIMUM AND MINIMUM)

GEOLOGIC INTERVAL	FLOW DIRECTION	DATE	K cm/sec.	dH/ dl	DARCIAN FT./DAY	DARCIAN FT./YR.	SEEPAGE FT./DAY	SEEPAGE FT./YR.
D	NE	10/17/90	4.95 E-4	.034	4.8 E-3	1.74	1.6 E-2	5.80
D	NE	06/19/90	4.95 E-4	.023	3.2 E-3	1.18	1.1 E-2	3.93
D	S	10/17/90	4.95 E-4	.022	3.1 E-3	1.13	1.0 E-2	3.76
D	S	12/17/90	4.95 E-4	.007	9.8 E-4	0.36	3.3 E-3	1.20
A	NE	06/19/90	4.07 E-4	.013	1.5 E-3	0.55	5.0 E-3	1.82
A	NE	04/02/90	4.07 E-4	.006	6.9 E-4	0.25	2.3 E-3	0.84
A	S	02/12/91	4.07 E-4	.009	1.0 E-3	0.38	3.5 E-3	1.26
A	S	12/17/90	4.07 E-4	.005	5.8 E-4	0.21	1.9 E-3	0.70

TABLE 2.3
TABLE SHOWING SAMPLING FREQUENCY, MEAN,
STANDARD DEVIATION, VARIANCE, AND STANDARD
ERROR OF THE MEAN FOR PCP AND TOTAL PNA CONCENTRATIONS
FOR ALL WELLS AT THOMASON LUMBER AND TIMBER COMPANY.
(VALUES LESS THAN DETECTION SET TO HALF THE DETECTION LIMIT)

ANALYTE	WELL	N	SAMPLE MEAN	STANDARD DEVIATION	SAMPLE VARIANCE	STANDARD ERROR OF MEAN
PCP	MW-1A	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-1CD	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-1D	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-2A	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-2D	6	0.004333	0.00072	0.000001	0.000295
PCP	MW-2E	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-4A	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-4D	6	0.002233	0.00097	0.000001	0.000396
PCP	MW-4G	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-5A	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-5C	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-5D	6	0.004892	0.00282	0.000008	0.001151
PCP	MW-6A	6	0.000500	0.00000	0.000000	0.000000
PCP	MW-6C	6	0.099183	0.11430	0.013065	0.046664
TOTAL PNA's	MW-1A	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-1CD	6	0.018167	0.00776	0.000060	0.003167
TOTAL PNA's	MW-1D	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-2A	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-2D	6	0.019417	0.00486	0.000024	0.001985
TOTAL PNA's	MW-2E	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-4A	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-4D	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-4G	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-5A	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-5C	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-5D	6	0.087333	0.08789	0.007725	0.035881
TOTAL PNA's	MW-6A	6	0.015000	0.00000	0.000000	0.000000
TOTAL PNA's	MW-6C	6	0.079333	0.11985	0.014365	0.048930

TABLE 2.4

TABLE SHOWING SAMPLING FREQUENCY, MEAN, STANDARD ERROR OF THE MEAN, AND CALCULATED UPPER AND LOWER CONTROL LIMITS FOR PCP AND TOTAL PNA CONCENTRATIONS FOR WELLS AT THOMASON LUMBER AND TIMBER COMPANY. DETECTION LIMITS REPLACED LOWER CONTROL LIMITS THAT WERE LESS THAN THE DETECTION LIMIT.

ANALYTE	WELL	N	SAMPLE MEAN	STANDARD ERROR OF MEAN	UPPER CONTROL LIMIT	LOWER CONTROL LIMIT
PCP	MW-1A	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-1CD	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-1D	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-2A	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-2D	6	0.004333	0.000295	0.00522	0.003448
PCP	MW-2E	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-4A	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-4D	6	0.002233	0.000396	0.00342	0.001044
PCP	MW-4G	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-5A	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-5C	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-5D	6	0.004892	0.001151	0.00834	0.001439
PCP	MW-6A	6	0.000500	0.000000	0.00050	0.000500
PCP	MW-6C	6	0.099183	0.046664	0.23917	-0.040808
TOTAL PNA's	MW-1A	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-1CD	6	0.018167	0.003167	0.02767	0.008667
TOTAL PNA's	MW-1D	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-2A	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-2D	6	0.019417	0.001985	0.02537	0.013462
TOTAL PNA's	MW-2E	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-4A	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-4D	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-4G	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-5A	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-5C	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-5D	6	0.087333	0.035881	0.19498	-0.020310
TOTAL PNA's	MW-6A	6	0.015000	0.000000	0.01500	0.015000
TOTAL PNA's	MW-6C	6	0.079333	0.048930	0.22612	-0.067458

TABLE 4.1

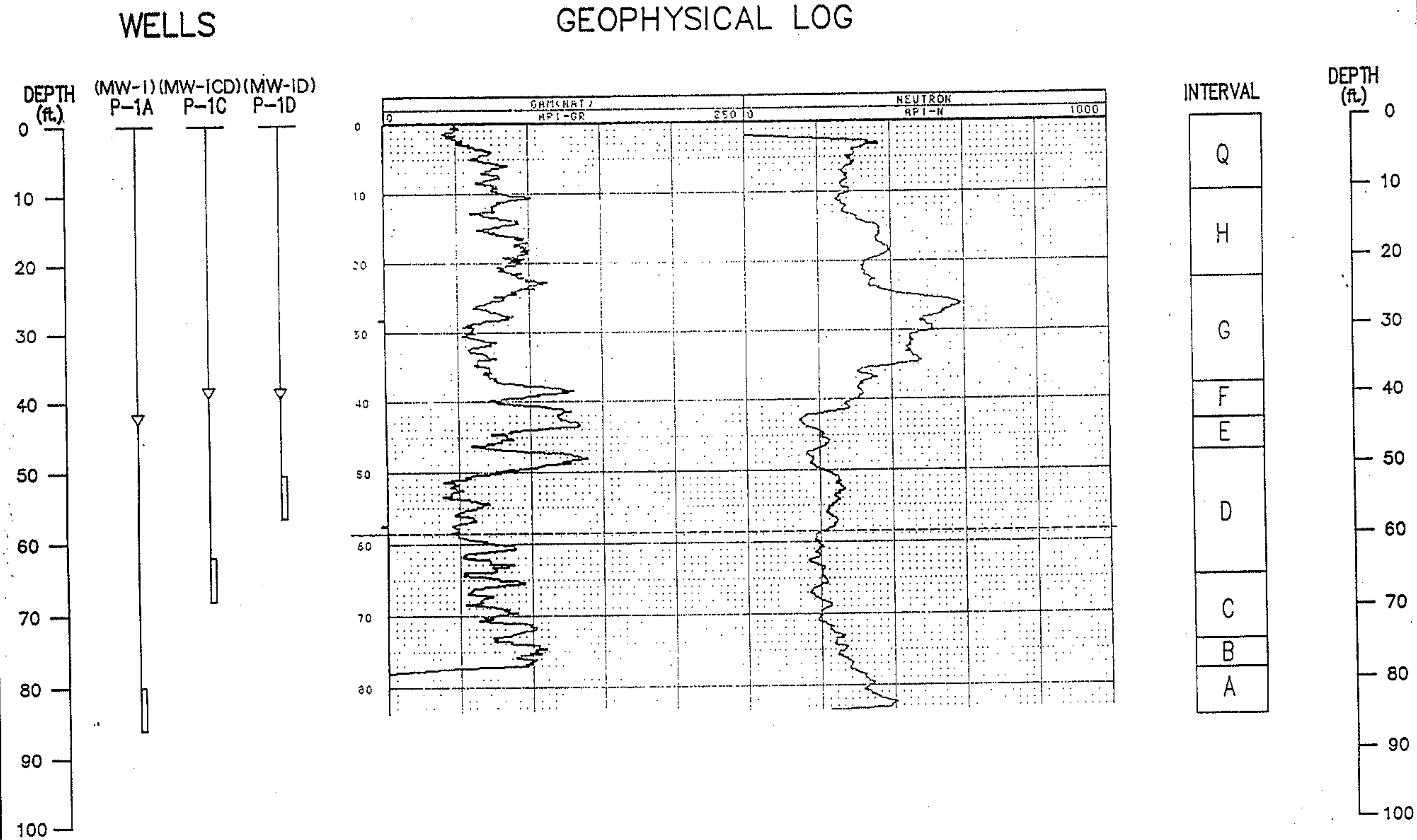
WATER-WELL AND GROUND-WATER USAGE SURVEY

LOCATION	TOTAL DEPTH (ft.)	DEPTH TO WATER (ft.)	TYPE	USE/ WATER QUALITY
1	NA	40 ± (Verbal)	Drilled	No - Salty
2	NA	8.17	Dug	Yes - Good
3	NA	4.58	Dug	No
4	NA	17.83	Dug	No
5 New	87 ± (verbal)	11.25	Drilled	Yes
6	NA	Filled w/Trash	Dug	NA
7	NA	21.25	Dug	Yes - Poor
8	NA	Filled w/Trash	Dug	No

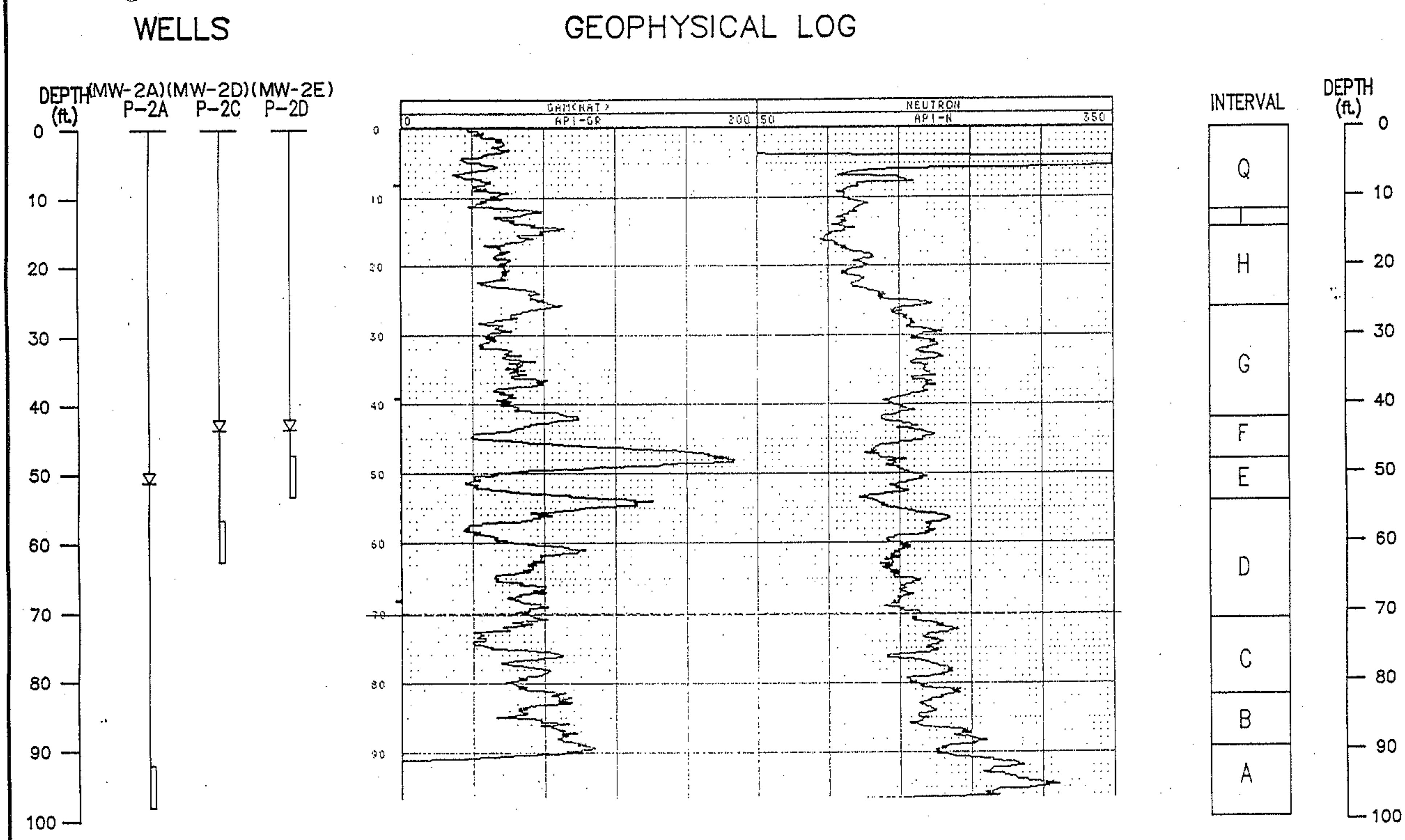
NA = Not Available

APPENDIX A

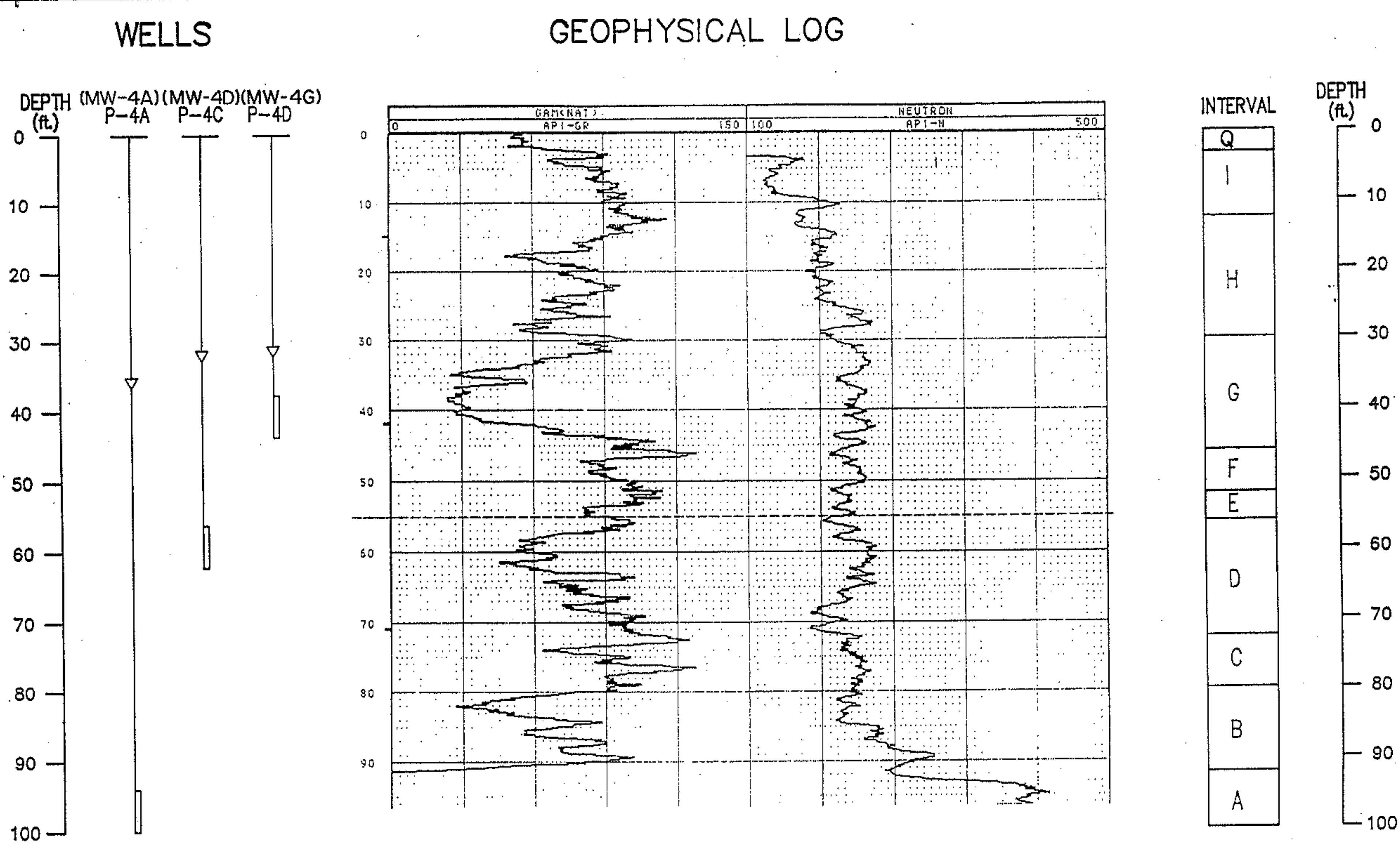
GEOPHYSICAL LOGS



DWN. CAF 5/91	B&F ENGINEERING, INC. 928 AIRPORT RD., HOT SPRINGS, ARK. 71913 767-2366		DWG. NO.
CK. PWB 5/91	GEOPHYSICAL LOG FOR WELL P-1 (MW-1)		
ACAD NO. 055	THOMASON LUMBER CO.		JOB NO: 7-2397-0101
APPROVED:			SCALE: AS SHOWN
	BROKEN BOW	OKLAHOMA	DATE: MAY, 1991



			B&F ENGINEERING, INC. 928 AIRPORT RD., HOT SPRINGS, ARK. 71913 767-2366	DWG. NO.
DWN.	CAF	5/91	GEOPHYSICAL LOG FOR WELL P-2 (MW-2)	
CK.	PWB	5/91	**THOMASON LUMBER CO.**	JOB NO: 7-2397-0101
ACAD NO. 051				SCALE: AS SHOWN
APPROVED:			BROKEN BOW OKLAHOMA	DATE: MAY, 1991



DWN.	CAF	5/91
CK.	PWB	5/91
ACAD NO. 052		
APPROVED:		

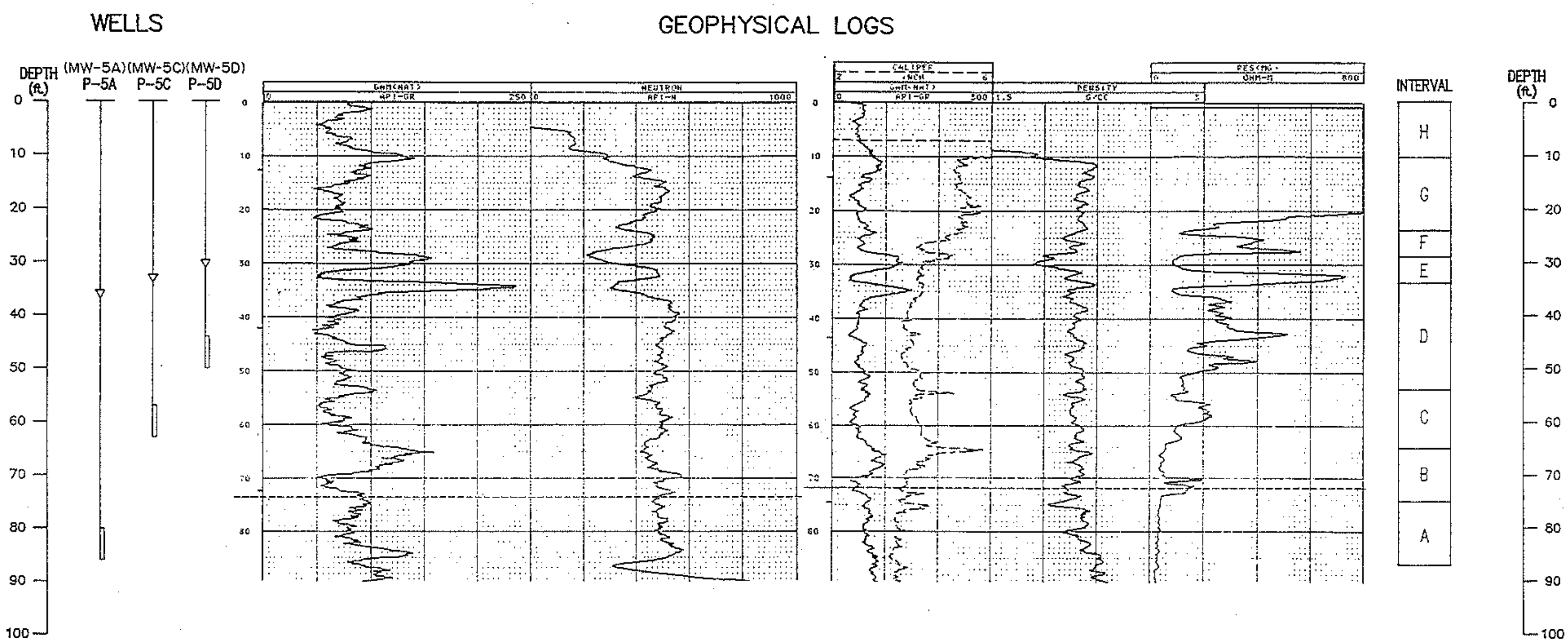
B&F ENGINEERING, INC.
928 AIRPORT RD., HOT SPRINGS, ARK. 71913 767-2366

GEOPHYSICAL LOG FOR WELL P-4 (MW-4)

THOMASON LUMBER CO.

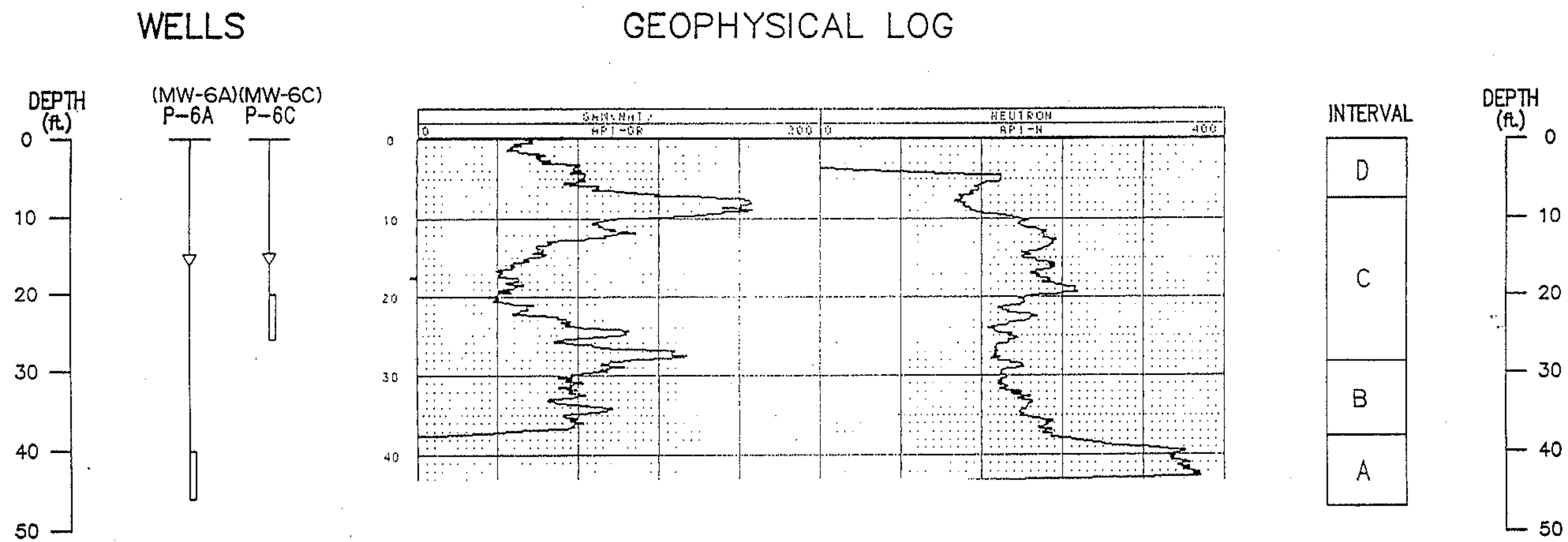
BROKEN BOW OKLAHOMA

DWG. NO.
JOB NO: 7-2397-0101
SCALE: AS SHOWN
DATE: MAY, 1991



	BY	DATE	
Design	PWB	5/91	**B&F** ENGINEERING, INC. 928 AIRPORT ROAD, HOT SPRINGS, ARKANSAS 71913 (501) 767-2366
Drawn	CAF	5/91	GEOPHYSICAL LOGS FOR WELL P-5 (MW-5)
Checked	PWB	5/91	THOMASON LUMBER CO.
Survey			
Fld.Bk.No.			BROKEN BOW OKLAHOMA

JOB NO.: 7-2397-0101
ACAD NO.: 054
SCALE: AS SHOWN
DATE: MAY, 1991



DWN.	CAF	5/91	B&F ENGINEERING, INC. 928 AIRPORT RD., HOT SPRINGS, ARK. 71913 767-2366	DWG. NO.
CK.	PWB	5/91		
ACAD NO. 053			GEOPHYSICAL LOG FOR WELL P-6 (MW-6) THOMASON LUMBER CO.	JOB NO: 7-2397-0101
APPROVED:			BROKEN BOW OKLAHOMA	SCALE: AS SHOWN DATE: MAY, 1991

APPENDIX B

CROSS-SECTIONS AND TRANSECTS